A STUDY OF THE HIBERNATION BEHAVIOUR OF *HYPENA ROSTRALIS* (L.) (LEP.: NOCTUIDAE) – THE BUTTONED SNOUT MOTH

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Abstract

The behaviour of *Hypena rostralis* prior to, during and after hibernation was studied in a wild population and in captive stock. The process of going into hibernation appeared to have two stages, the first at the end of September when movement in and out of the hibernation site still continued and a second in late November when the adults began to settle down. By early December they had become inactive and remained in this state until March or early April when movement started again. They left the hibernation sites by 26 April. The movement seems to be triggered by day length rather than temperature. The use of buildings may be atypical and natural sites may be favoured.

Introduction

Butterfly Conservation reports were the main source of information for this project, but smaller articles by Waring (in press), Plant (1987), Frohawk (1934) and Wedd (1986) were all reviewed. Down (2004) described encounters with adult moths from the 1950s and 1980s and the large numbers found hibernating in underground bunkers in East Tilbury from 1989 to the present day.

The moth is classed as Nationally Scarce as it was thought it had declined significantly (UK Biodiversity Group 1999). The demolition or removal of old buildings and the flailing of hedgerows containing *Humulus lupulus* Hop, *Rubus* spp. Bramble, and *Salix caprea* Sallow would appear to be part of the possible reason for the reduction in numbers (Townsend, 2002). It is possible that the reduction in records in recent years could well be erroneous because it relies on modern records from light-traps instead of more traditional field techniques such as beating for larvae (Collins, 2000). Findings from Field and Watkins (2005) agree as larvae seemed to be far more common in Essex and Cambridgeshire than the records from light-trapping might suggest. At Writtle only one adult has been caught over the period 1968-2004 in the Rothamsted light trap (Gardiner & Field, 2001; Field & Watkins, 2005) even though larvae have been found on the surrounding *H. lupulus* plants and there are adults hibernating only 300 m from the trap.

Hibernation is a strategy that allows organisms to survive unfavourable periods. This period of dormancy is governed primarily by day length. Temperature tends to fluctuate wildly at all times, but the alternation of night and day, or changes in day length throughout the year, have shown regular and exact rhythms for millions of years. Moths have adapted to these rhythms and make use of them (Novak, 1999; Young, 1997).

Other factors, including temperature, also play a role. Temperature is a basic factor controlling the life of moths and activity can only take place within a certain temperature range. Below this range activity is reduced to the basic physiological process required for survival. Being cold-blooded, the temperature of moths is largely determined by the external environment. Once they have reached some minimum temperature they can further raise their temperature by flapping their wings and thus become active (Novak, 1999). Conversely, once their temperature has fallen below some minimum temperature they are unable to generate enough heat and so they must become inactive.

In temperate species hibernation is intense from November to January, the unfavourable winter period, and hibernation can consist of several phases (Novak, 1999). This is suggested to apply to this moth, which appears to be virtually inactive at this time, over-wintering in the adult stage (Down, 2004).

Methods

A large range of buildings were searched during January and February of 2003 (Table 1), and the winters of 2003/4 and 2004/5. All the sites searched were adjacent to where larvae had been discovered on *H. lupulus* and in most cases these buildings formed the nearest buildings to the site.

Table 1. Buildings searched for hibernating adults in January/February 2003

Site	Wooden	Brick/stone	Steel	Concrete
Writtle College	all	all	all	all
Gunpowder mills Waltham Abbey		11		10
Southend Priory Park		3	1	
Southend Park Lane	2	1		
Writtle Church		1		
Garage, Dovercourt		Asbestos		
Pill boxes at TL 6026 and TL 5926				4
Garage at TL 6026	1			
Hollow tree at TL 6026				

In early August 2003 a large cage was erected at Writtle College. The cage had a double membrane floor and had two *H. lupulus* plants in large tubs and growing up trellis installed in it. Cut nectar sources such as *Achillea millefolium* Yarrow, *Senecio jacobaea* Ragwort, *Cirsium arvense* Creeping thistle, *Cirsium vulgare* Spear thistle and *Arctium minus* Burdock were placed in bottles of water within the cage. These were replaced throughout the season with flowering plants which could be suitable nectar sources for the adults. A purpose built hibernation chamber was placed within the cage on 20 August 2003 and three data loggers were installed; one outside the

cage, one inside the cage and one inside the hibernation chamber. Between 11 August and the 28 August eight adults and four larvae were released into the cage. Their behaviour was then monitored throughout the period until hibernation ceased.

A sports equipment store of brick construction with no windows, wooden roof supports, asbestos roof and double garage doors also used by the adult for hibernation had a data logger installed on the 26 September and was monitored frequently during the hibernation period.

The data from this project was examined for indications of the conditions that trigger the moth's hibernation behaviour. As the minimum temperature will have the most influence on the moth's hibernation activity, it is this temperature, together with day length, that has been concentrated on. Where there was evidence of extremely high winds, either from local reports or damage at the site, this was taken into account. It is important to remember that this data is based on observations over only one and a half seasons with relatively few individuals at two sites.

Results

Survey of buildings

Live adults were identified at two sites plus a dead adult was found at a third. The first three adults were discovered in October 2002 in a garage where *H. rostralis* had been known to hibernate before. This was next to the site where larvae were beaten from *H. lupulus* in 2001 (Field, 2003). By early February, when checked again, they had disappeared. The second site where an adult was observed was in a garage on the Writtle College estate. In the winter of 2003-4 one adult was again found hibernating in that garage, while in 2004-5 four adults were noted in December 2004. A dead adult was also discovered on the College estate in 2003, but this time in a farm building. The area where the moth was discovered was used as a staff rest room and the moth was dead on the back of an arm chair.

Large numbers of *H. rostralis* have been observed hibernating at a site in East Tilbury over the last 14 years (Down, 2004). This site was searched on 2 February 2004 and 48 adults were found, of which 13 were males and 35 females. They were all hibernating alone with the nearest adult usually being about 2-3 metres away. In one bunker there were 22 (4 males & 18 females). In a second bunker there were 25 adults (9 males & 16 females), while in the third bunker, which was larger and darker and had cork on the walls, only one female was found.

Entering hibernation in the wild (autumn 2003)

The moths were variously present and absent from the time of first sighting (26 September) until 24 November, when it became present more frequently. Up until this time the minimum temperature had not fallen below 0.7°C and the day length had reduced to 10.1 hours. Between 27 November and 5 December the moth was present but moving intermittently. The minimum temperature of -1.4°C was on the 28 November and by the end of the period the day length had reduced to 8 hours.

Prior to 28 the minimum temperature had fallen steadily from 11°C (19th) to 1.1°C (27th). Activity ceased from 9 December until the end of March the following year. The minimum temperature had reached -2.2°C (8 December) and day length 7.92 hours (Table 2).

Table 2. Entering hibernation - autumn 2003.

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
25-29/9	2	5.8 to 15.3	11.9 to 11.7	1 adult left 26/9 second left 29/9 after slight movement
30/9-6/10	0	5.8 to 13.5	11.65 to 11.25	
7/10	1	8.0	11.18	
8/10 to 21/10	0	0.7 to 13.1	11.12 to 8.53	
24/10	1	3.9	8.4	
25/10	0	2.7	8.37	
27/10 to 5/12	1	-1.4 to 7.3	8.27 to 8.0	Moved intermittently (max 20 cm)
8/12	0	-2.2	7.93	
9/12 to 23/1	1	-5.3 to 9.1	7.92 to 8.67	No movement

Entering hibernation – a study using captive stock (autumn 2003)

The moths were active within the cage up until 26 September, when they began to settle for days in the same place. Just prior to this time the minimum temperature had fallen to -2.2°C and the day length had reduced to 11.9 hours. A moth was present in the hibernation chamber between 7 October and 4 November, and others were moving intermittently about the cage, being seen less frequently as time went by. Between these dates the minimum temperature had varied between -4.9°C (28 October) and 7.7°C (10 October), and day length had reduced to 9.42 hours. Between the 5 and 18 November the moths in the hibernation chamber and the cage became more active. Between these dates the minimum temperature was 0.1°C and the day length reduced to 8.67 hours. Activity ceased from 4 December until January the following year. The minimum temperature had reached -0.1°C (9 November) and day length 8.05 hours. Prior to 4 December, the minimum temperature had risen from -4.4°C (28 November) to 6.9°C (4 December) (Table 3).

Entering hibernation

The moths seemed to begin to settle down from about 26 to 29 September. The day lengths for this period ranged between 11.7 and 11.9 hours. The minimum temperature in the previous week ranged between -2.2 and 15.3°C. The moths become more settled between 18 and 24 November. The day lengths for this period ranged between 8.4 and 8.67 hours. The minimum temperature in the previous week ranged between 1.5 and 11.0°C. Activity ceased between 4 and 9 December. The day lengths for this period ranged between 7.92 and 8.05 hours. The minimum temperature in the previous week ranged between -4.4 and 7.3°C (Table 4).

Table 3. Entering hibernation - autumn 2003

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
23/9 to 26/9	1 to 4	-2.2 to 1.1	11.9	Adults seen in varying locations
29/9 to 6/10	1 to 4	-0.6 to 11.3	11.7 to 11.25	Some adults in same place for more than one day
7/10 to 16/10	1 in hc	1.9 to 7.7	11.18 to 10.6	Other adults in varying locations
20/10 to 4/11	1 in hc	-4.9 to 6.5	10.35 to 9.42	Other adults seen occasionally
5/11 to 11/11	1 in hc	-0.1 to 7.3	9.37 to 9.03	2 other adults seen daily in cage
13/11 to 17/11	2 in hc	0.7 to 11.7	8.92 to 8.67	One other adult seen in cage on 13/11
18/11 to 3/12	1 in hc	-4.4 to 10.2	8.58 to 8.07	Occasional change of position
4/12	1 in hc	6.9	8.05	No further movement until January

hc – hibernation chamber

Table 4. Entering hibernation 2003.

Dates and day lengths	End summer activity (date)	End summer activity (day length)	Begin to settle down (date)	Begin to settle down (day length)
Wild	26/09/03	11.9	24/11/03	8.40
Captive	29/09/03	11.7	18/11/03	8.67

Previous 7 days MINIMUM temp	End summer activity Min (°C)	End summer activity Max (°C)	Begin to settle down Min (°C)	Begin to settle down Max (°C)
Wild	not known	15.3	6.9	11.0
Captive	-2.2	7.3	1.5	7.3

Dates and day lengths	Become inactive (date)	Become inactive (day length)
Wild	26/09/03	11.9
Captive	29/09/03	11.7

Previous 7 days MINIMUM temp	Become inactive Min (°C)	Become inactive Max (°C)
Wild	-2.2	7.3
Captive	-4.4	6.20

Wild = Inside the store at Writtle College.
Captive = Inside the hibernation chamber in the cage at Writtle College.

Emergence from hibernation in the wild – spring 2003

Prior to the first movement (21 March) the minimum temperature had not fallen below freezing for 25 days and day length had reached 12.15 hours. The fall in minimum temperature between 7 April and 13 April seems to coincide with the moth not moving. Prior to the moth leaving the minimum temperature rose on the 14 April and remained at a warmer level for about 6 days and day lengths had reached 14.12 hours (Table 5).

Table 5: Emergence from hibernation in the wild - spring 2003.

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
14/1 to 19/3	1	-3.5 to 8.8	8.35 to 12.15	No movement
21/3	1	4.3	12.28	Slight movement
24/3 to 2/4	1	3.9 to 8.8	12.48 to 13.07	Slight changes in orientation from original
3/4 to 16/4	1	0.3 to 10.6	13.15 to 13.98	No movement
18/4 to 20/4	0	6.5 to 9.9	14.12 to 14.25	Left hibernation

Spring 2004

Prior to the first significant movement (1 April) the minimum temperature had not fallen below freezing for 28 days and day length had reached 14.43 hours. The movement on 1 April seems to coincide with a marked rise in the minimum temperature on that day. Prior to the moth leaving (20-23 April) the minimum temperature rose sharply on the 21 April (20: 3.1, 21: 10.6) and day lengths had reached 14.3 hours (Table 6).

Table 6. Emergence from hibernation - spring 2004

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
9/12 to 23/1	1	-2.2 to 7.7	7.92 to 8.67	No movement
26/1 to 30/3	1	-3.1 to 11.3	8.82 to 12.87	Slight movement
1/4	1	9.9	13.02	Moved 1.5 m
2/4 to 20/4	1	1.5 to 9.5	13.07 to 14.25	Moved 0.5m on 2/4 then no movement
23/4	0	7.7	14.33	Left hibernation

Emergence from hibernation – a study using captive stock (spring 2004)

Prior to the first significant movement (Monday, 12 Jan) the minimum temperature had not fallen below freezing for 8 days and day length had reached 8.2 hours. There had been very high winds the previous weekend. The original moth in the hibernation chamber began moving before the introduction of more moths (4 Feb).

The introduced moths may have taken time to find a satisfactory place to hibernate within the cage. This might account for the various movements of those visible within the cage between 9 Feb and 14 April, although there was a general rise in minimum temp from the 9 to 21 March. The minimum temp only fell below freezing again on 25 and 26 March but reached 9.9 on 16. The frame of the cage was found to have been bent, probably by the wind, at some time between the 4th and 23rd of March and there was further evidence of high wind again on 5 and 7 April. When the first moth left the hibernation chamber (14 - 15 April) the minimum temperature had dropped from 5.8 (13) to -0.1 (14). The minimum temp rose and fell again (-1.8, 20) but after that did not fall below freezing again and the moths left on the nights of 23, 24 and 26. Day length had reached 14.62 hours (Table 7).

Table 7. Emergence from hibernation - spring 2004

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
4/12 to 6/1	1 in hc	-5.8 to 7.7	8.05 to 8.00	No movement
12/1 to 4/2	1 in hc	-4.4 to 11.7	8.2 to 9.32	Move occasionally
4/2	7 in hc			6 moths introduced
9/2 to 1/3	4 in hc	-6.3 to 7.7	9.6 to 10.95	2 in cage
4/3	3 in hc	4.6	11.15	2 in cage
23/3 to 14/4	4 in hc	-2.2 to 8.8	12.42 to 13.87	2 in cage
15/4 to 26/4	1 to 3 in hc	-1.8 to 9.5	13.92 to 14.62	2 in cage
27/4 to 18/5	0 in hc	4.3 to 10.2	14.67 to 15.83	2 seen in cage but none after 18/5

The moths begin to move between 12 January and 1 April. The day lengths for this period ranged between 8.2 and 13.02 hours. The minimum temperature in the previous week ranged between 1.1 and 6.9°C. The moths left their hibernation shelter between 14 April and 26 April. The day lengths for this period ranged between 13.87 and 14.62 hours. The minimum temperature in the previous week ranged between -2.2 and 10.6°C (Table 8).

Discussion

Entering hibernation

After the summer the moths appear to begin to investigate different hibernation sites from about 26 September. They become more settled at about 18 to 24 November, and these varying periods of activity and inactivity last until about 4 to 9 December, when activity ceases. This appears to demonstrate distinct stages of preparation for hibernation. They appear to investigate hibernation sites as a response to day lengths. Although the day lengths were almost the same for both locations, the preceding week's minimum temperature had a wide range. This seems to indicate that they begin to settle as a response to day length, regardless of the temperature.

Table 8. Emergence from hibernation spring 2003 and 2004.

Dates and day lengths	First movement (date)	First movement (day length)	Leave hibernation (date)	Leave hibernation (day length)
Wild Spring 03	21/03/03	12.28	18 - 20/04/03	14.12 - 14.25
Wild Spring 04	01/04/04	13.02	20 - 23/04/04	14.25 - 14.43
Captive Spring 04	12/01/04	8.2	14 - 26/04/04	13.87 - 14.62

Previous 7 days MINIMUM temp	First movement Min (°C)	First movement Max (°C)	Leave hibernation Min (°C)	Leave hibernation Max (°C)
Wild Spring 03	1.1	5.4	0.7 - 5.4	10.6 - 10.6
Wild Spring 04	2.3	6.9	4.6 - 3.1	8.4 - 10.6
Captive Spring 04	2.3	5.4	-2.2 - -1.8	5.8 - 9.5

Emerging from hibernation

Generally the moth remains inactive during the winter months, and first begins to move in the spring but remains within its winter shelter. After various periods of activity and inactivity within the shelter the moth leaves. It appears that the moth becomes aware that it should prepare to leave the shelter of the hibernation site and, when all the required conditions are met, it leaves. In this instance it is not clear whether day length or minimum temperature influenced the first stirring of the moth, as the day lengths and the minimum temperature both had a wide range. It might be significant that the temperature had not fallen below freezing in the previous week or more, regardless of the day lengths. But it is possible that they leave their place of hibernation as a response to day length, regardless of the temperature. When they left the place of hibernation the day lengths had reached about 14 hours whereas the previous week's minimum temperature had ranged between -2.2 and 10.6°C.

The captive spring 2004 data differs in that the first activities were considerably earlier than the wild data. The hibernation chamber was not as stable as the brick store, and all of the earlier-than-usual movements made by the original moth may have been in response to the high winds or other disturbance and not by the previous week's above-freezing temperatures. The moth in the store in the spring of 2004 may have changed orientation slightly (26 January) after a similar period of above-freezing conditions. However, after this minor adjustment it did not move again until 1 April. There had been similar periods of above-freezing conditions in between, for example around the 3 and 15 February. However, it should be noted that the moths in the hibernation chamber appeared undisturbed by the high winds evident on 5 and 7 April and these were also preceded by similar periods of above-freezing conditions.

The moth has probably two distinct phases of hibernation. The moths might enter a midway stage between hibernation and full activity, triggered by some element in their environment. If this stage were triggered by above-freezing conditions throughout the preceding week, then the uncharacteristic early activity could have been due to high winds buffeting the unstable hibernation chamber when the moth was in this midway stage. However, on other occasions similar conditions did not appear to cause any disturbance to other moths in the hibernation chamber. The last moths left the hibernation chamber slightly later than the wild moths left the store.

It was possible that unusually early movements of the moth in the hibernation chamber in the spring of 2004 were atypical. The chamber may not have been an ideal environment for the moth to hibernate in. If the atypical result was excluded the revised data would be as found in Table 9.

Table 9. Movement spring 2003 and 2004.

Dates and day lengths	**First movement (date)**	**First movement (day length)**	**Leave hibernation (date)**	**Leave hibernation (day length)**
Wild Spring 03	21/03/03	12.28	18 - 20/04/03	14.12 -14.25
Wild Spring 04	01/04/04	13.02	20 - 23/04/04	14.25 -14.43
Captive Spring 04	04/03/04	11.5	14 - 26/04/04	13.87 -14.62

Previous 7 days MINIMUM temp	**First movement Min (°C)**	**First movement Max (°C)**	**Leave hibernation Min (°C)**	**Leave hibernation Max (°C)**
Wild Spring 03	1.1	5.4	0.7 - 5.4	10.6 - 10.6
Wild Spring 04	2.3	6.9	4.6 - 3.1	8.4 - 10.6
Captive Spring 04	-6.3	-1.8	-2.2 - -1.8	5.8 - 9.5

In this case the moths began to move between 4 March and 1 April. The day lengths for this period ranged between 11.5 and 13.02 hours. The minimum temperature in the previous week ranged between -6.3 and +6.9°C. This seems to indicate that day length might be more important than temperature to trigger the first movement. The days had all reached similar lengths whereas the previous week's minimum temperatures had a wide range and the data for leaving the hibernation sites is similar.

Hibernation is not as simple as the adults using the nearest suitable buildings. Many suitable buildings near large stands of *H. lupulus* have been searched and hibernating adults have only been located in two such buildings. Finding hibernating adults in natural locations is almost impossible but is suspected to be the norm. The moths showed no interest in leaving the hibernation sites in warm spells in spring and the first adults recorded at light-traps tend to occur around the end of April which agrees with our assessment that the adults leave hibernation around 20 April.

This study, based on limited data, indicates that the moth's hibernation behaviour seems to be governed more by day length than temperature, although cold weather in early April may delay their departure, and cold weather in early December may influence the beginning of their period of total inactivity.

Acknowledgements

This paper is based on research carried out under a Biodiversity Action Grant from English Nature for English Nature project BGN/169 *Hypena rostralis* Buttoned snout moth. The aim of the project was to conduct autecological research to inform habitat management and this paper discusses the hibernation part of the lifecycle. The research was based mainly in Cambridgeshire and Essex, ands funding was also given by the Cambridgeshire and Essex Branch of Butterfly Conservation. Much of the research has been carried out in conjunction with the Centre for Environment and Rural Affairs (CERA) at Writtle College, Chelmsford, Essex, where the authors were based.

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